ARMY

Submission of Proposals

The responsibility for the implementation, administration, and management of the U.S. Army Small Business Technology Transfer (STTR) Program rests with the Army STTR Program Manager at the U.S. Army Research Office (ARO). You are invited to submit STTR proposals to ARO at the US Postal or physical addresses below. Proposals must be received at ARO no later than the required solicitation closing date and hour. Instructions in the Solicitation are augmented with these specific Army requirements.

<u>Physical Address for Private Delivery Services</u>
U.S. Army Research Office
ATTN: STTR-2000 (LTC Jones)
4300 South Miami Blvd
Durham, NC 27703-9142
Telephone: 919-549-4200

<u>Mailing Address for U.S. Postal Service</u>
U.S. Army Research Office
ATTN: STTR-2000 (LTC Jones)
P.O. Box 12211.
Research Triangle Park, NC 27709-2211

The Army has identified eight topics, numbered ARMY00-T001 through ARMY00-T008, to which small businesses and their partner research institutes may respond. Only proposals addressing these topics will be accepted for consideration for Phase I of the Army STTR Program.

The Army anticipates sufficient funding to allow award of one to three STTR Phase I contracts to firms submitting the highest quality proposals in each topic area. Awards will be made on the basis of technical evaluations using the criteria contained in the solicitation within the bounds of STTR funds available to the Army at the time of award. If no proposals in a topic merit award relative to the proposals received in other topics, the Army will not award any contracts for that topic.

Proposals for Phase I are limited to a maximum of $100,000 over a period not to exceed **six** months.

Based upon the progress during a Phase I contract, a firm may be invited to propose Phase II. Any Phase II contracts resulting from Phase I proposals submitted for this solicitation will be limited to a maximum of $500,000 over a period of two years. Phase II contracts will be structured as a single year contract with a one year option.

Army STTR 00 Topic Descriptions

ARMY00-T001 TITLE: A Polyphosphazene-Based Membrane-Electrode Assembly for a Direct Methanol Fuel Cell

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PM Soldier

OBJECTIVE: Using a polyphosphazene-based cation-exchange polymer, develop a membrane-electrode assembly for use in a direct methanol fuel cell (DMFC) that exceeds state-of-art performance of presently employed perfluorosulfonated materials. Although not the focus of this solicitation, a long-term objective is to develop a 10-50 W/1000Wh DMFC power system for the dismounted soldier.

DESCRIPTION: The Army, and particularly the Dismounted Soldier, has need for high-energy, lightweight power sources. Polymer electrolyte membrane fuel cells (PEM FCs) are candidates to fill these needs. Hydrogen-air fuel cells (H/A FC) based upon perfluorosulfonated ionomer (PFSI) membranes (e.g., NafionÓ) have been developed to the point where they can augment the soldier's power needs, but lack of a convenient, inexpensive, and safe source of hydrogen is a significant impediment to their use. Methanol, in direct electrochemical combustion, is an alternative fuel for which these difficulties do not exist, but the power density of a DMFC is below that of an H/A FC. One cause of the lower power density originates from methanol crossover through the PFSI PEM from the anode to the air cathode. New, less-methanol permeable PEMs are required to improve the performance of a DMFC (1, 2). Polyphosphazene-based, cation-exchange membranes show promise in this application. For example, a sulfonated and crosslinked polyphosphazene membrane has a conductivity approximately half that of Nafion 117, but with a methanol permeability approximately a factor of ten less (3).

PHASE I: Develop processes to fabricate a viable membrane-electrode assembly (MEA) for an air-fed DMFC using a polyphosphazene-based, cation-exchange polymer and evaluate these MEAs in a single-cell arrangement. Performance must exceed state-of-art PFSI-based DMFCs. Identify and discuss the critical issues in developing a low-cost, efficient manufacturing process to produce viable polyphosphazene-based MEAs.

PHASE II: Address the critical processing issues identified in Phase I to produce polyphosphazene-based MEAs. Develop a "benchtop" 10-50 W DMFC cell stack using these MEAs. Identify and address system issues that are unique to the polyphosphazene-based DMFCs such as thermal and water management.

PHASE III DUAL USE COMMERCIALIZATION: Developments in DMFC power sources will have immediate impact on a wide range of commercial power sources from computer power to emergency medical power supplies to recreational power uses.

REFERENCES:
1) C. Martin and D. DesMarteau, "Advanced PEM fuel cell membranes and membrane-electrode assemblies for non-conventional fuels," ARO Workshop Report, Clemson University (1999).
2) B.S. Pivovar, Y. Wang, and E.L. Cussler, J. Membrane Sci., 154 (1999) 155-162.
3) Q. Guo, P.N. Pintauro, H. Tang, and S. O'Connor, , J. Membrane Sci., 154 (1999) 175-181.

KEY WORDS: Fuel cell, direct methanol fuel cell, membrane-electrode assembly, polyphosphazene, soldier power

ARMY00-T002 TITLE: 3D Woven Composites for New and Innovative Impact and Penetration Resistant Systems

TECHNOLOGY AREAS: Materials/Processes, Human Systems

OBJECTIVE: To develop innovative methodologies and techniques for the use of 3D woven composites for significantly new and improved structural and mechanical applications pertaining to penetration and impact resistance. Reliable processing techniques for matrix resin application and optimization of 3D woven architectures for textile woven composites that can be tailored to resist and mitigate penetration are to be developed. Experiments and computational tools should be used to determine overall strength and response of these systems under impact loading conditions for the development of reliable design guidelines for new and significantly improved high strength and low-weight applications, such as body armor, structural systems, and mechanical components.

DESCRIPTION: Three-dimensional woven fibrous assemblies are textile architectures having fibers oriented along the three surfaces of a unit cell. The lack of kinematics constraints can allow the processing of novel composite architectures with desired thermo-mechanical response. In 3D woven structures, fibers are intertwined, interlaced or intermeshed in the cross-wise, lengthwise, and thickness directions. Recent automated manufacturing techniques have substantially reduced costs and significantly improved the potential for large-scale production. 3D textile woven composites, processed to date, have shown impressive multi-directional strength characteristics for structural and mechanical applications under quasi-static loading conditions. However, optimal orientations and distributions of warp, web, fill, and surface yarns, resin types and infiltration techniques, and preform geometeries have yet to be fully developed and perfected for 3D woven composites subjected to impact loading conditions. Once optimal combinations of these variables can be determined, new methodologies can be further developed on how to utilize inherent mechanisms of 3D woven composites for energy dissipation and strengthening.

PHASE I: Demonstrate the feasibility of tailored 3D textile composite architectures by using dynamic experiments and computational tools to determine response as a function of 3D woven fabrics, fiber orientations, distributions, and volume fractions, resin types, and preforms. These interrelated tools should be used in conjunction with cost-effective processing techniques to determine optimal 3D textile composite architectures. Comparisons with 2D woven architectures should be undertaken, as a benchmark, to assess performance and durability, and to delineate advantages of 3D woven systems. Prototype designs that can be efficiently processed fabricated, and tailored to resist high velocity impact and penetration should be developed.

PHASE II: Prototype designs from Phase I should be specialized to a specific structural and mechanical application, such as body armor protection vests, helmets, or structural components that can be efficiently manufactured. Experiments and computational tools should be used to assess and evaluate the durability and performance of these designs to realistic threats and dynamic loading conditions. Reliable guidelines should be then be developed for the design, processing, and fabrication of these prototypes for batch production.

PHASE III DUAL USE COMMERCIALIZATION: There are a large number of dual use applications. 3D woven textile architectures can be used for high strength, lightweight, and damage tolerant applications, such as body armor (vests, helmets, soles for anti-mine shoes), bomb containment devices, and as structural elements and components in military and commercial vehicles, off shore marine platforms, shelters, automotive and marine components, and hardened structures.

KEYWORDS: 3D textile composite architectures, impact and penetration, fiber volume fractions, 3D fabrics, preforms, energy dissipation mechanisms, resin techniques

REFERENCES:

1. V.R. Aitharahju, and R.C. Averill, "Three-Dimensional Properties of Woven-Fabric Composites," Composites Science and Technology. Vol. 59 no. 12, p. 1901, 1999.

2. G. Zhu, W. Goldsmith, and C.K.H. Dharan, "Penetration of Laminated Kevlar by Projectiles-I, Experimental Investigation," International Journal of Solids and Structures, Vol. 29, no. 4, p. 399, 1992.

ARMY00-T003 TITLE: <u>High Strength, Damage Tolerant Structures From Novel Layer Geometries</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop structural components with layer geometries specifically designed to increase the strength and damage tolerance properties under complex loading conditions, and to develop computationally and experimentally optimized design guidelines for the layer geometries in these components.

DESCRIPTION: Research in metallic, ceramic, polymeric, and composite layered materials has often demonstrated an increased strength and fracture toughness of these materials compared to their homogeneous or non-layered equivalents; the mechanisms identified to explain these increased mechanical properties include crack deviation and interfacial debonding. Recent preliminary work has demonstrated the further advantage of materials with a corrugated laminate geometry for increased penetration resistance (i.e., K.S. Vecchio). It has therefore been demonstrated that not only the layering of materials, but also the geometry of these layers, has a significant impact on the mechanical properties of the resulting structures; it is expected that materials with novel layer geometries could be optimized for improved strength/performance to weight ratios and damage tolerance properties. Such materials would be highly relevant to the Army's interest in developing lightweight and damage tolerant vehicles and structures. What is desired is: (1) development of the synthesis and processing technology required for the low-cost fabrication of structures utilizing advanced layer geometries for increased strength and damage tolerance, (2) an integrated experimental and computational characterization of the influence of layer geometry on the strength and damage tolerance (i.e., deformation, fracture, fatigue, etc.) of these structures, and (3) the establishment of optimal, and preferably tunable, design parameters for structures with maximum strength and damage tolerance.

PHASE I: Demonstrate the fabrication of a representative component and the optimization of its strength and damage tolerance properties via novel layer geometry in order to evaluate the potential for the production of a complex component for DOD and commercial applications. The critical processing steps should be identified and the preliminary materials characterization and testing (both experimental and computational) should be performed.

PHASE II: Conduct additional experimental and computational characterizations as required, and document expected strength, performance, and damage tolerance capabilities and projected cost savings. Demonstrate the technological advances achieved in strength and damage tolerance via the production of a prototype component with optimized layer geometry.

PHASE III DUAL USE COMMERCIALIZATION: Incorporate structural components with optimized layer geometry into aircraft, rotorcraft, road, rail, or other transportation vehicles or systems in order to improve strength/performance to weight ratios and damage tolerance properties. Optimize the process and component design for fabrication on a plant scale. For DOD, these materials could provide enhanced strength/performance to weight ratios and damage tolerance properties in order to lighten forces and increase functionality under complex loading conditions. Materials incorporating novel layer geometries could also serve as replacements for commercial transportation systems and even sports equipment.

KEY WORDS: Layer geometry, fabrication, high strength, damage tolerance

ARMY00-T004 TITLE: Hand-held and Head-mounted Microdisplays for the Dismounted Soldier

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: To take advantage of recent developments in "microdisplays," which have very high resolution, are about 0.75 inch cube in size, are robust, have full color, and consume very little power. These can be adapted to the needs of the individual soldier both as hand-held and head-mounted display units, for the soldier to communicate with Command Control Communication headquarters while on the move. Bringing together recent S&T advances in visual Displays adapted to the needs of the Land Warrior, this STTR effort will provide a springboard for advancements towards "Future Operational Capabilities" (FOCs) being advocated by TRADOC (Training and Doctrinaire Command). In addition, it will show new pathways for advanced civilian applications through promotion of the related R&D, and will advance civilian commerce.

DESCRIPTION: Recently, liquid crystal and electroluminescent versions of microdisplays have been produced that together with other advances in materials science show the potentiality of meeting the display requirement for the individual soldier. Specifically, liquid crystal and electroluminescent science has progressed to a point that these advances need to be configured into such displays, and assessed with regard to the overall Land Warrior System. Among the advances is a class of liquid crystal materials that have been produced which are immune to exposure to extremes in the military range of temperatures, and others which can produce analogue gray scales. It is also necessary to integrate these advances with RF signal processing components to craft a system that the soldier can use. The time is right to integrate such advances first into a hand-held version and thereafter into a helmet-mounted display (HMD) for the Land Warrior that is compatible with his/her helmet-mounted night vision means as well.

PHASE I: Via an interdisciplinary research effort develop materials for display that will satisfy operational capability requirements detailed below for microdisplays for the Land Warrior. The RF requirements, power consumption limits, information throughput rate, security in communication, robustness to shock and temperature variation over the military range, and compatibility with other systems requirements for the soldier in the battlefield will be investigated, quantified, and display materials will be developed accordingly. Already at this stage, the materials to be developed will have to be able to function in a "display system" having optimal properties with respect to: a)Total weight including cabling for RF communication and power; b) Storage and operability over the military temperature range; c) Pixel density/resolution needed for carrying out battlefield functions including viewing, reception and transmission of imagery and symbology; d) See-through versus occluded vision constraints and field of view; e) "Stow-ability" of imagery/information for future at-will use; f) Immunity to shock levels expected to be encountered by the dismounted warrior; g) Compatibility with night vision devices mounted on helmet, compatibility with RF components for communication with "buddies" and upper echelons. For guidance on quantitative values that satisfy TRADOC requirements, see TRADOC documents at web site: http://www-tradoc.army.mil.

PHASE II: Develop, based on the results/conclusions of Phase I, two prototype deliverable microdisplay systems. The first deliverable should be a palm-sized hand-held microdisplay communication system for the solider on the move. Based on this work, a helmet-mounted version will be developed that pays attention to: human vision and ergonomic requirements, such as proximity to the eye, field of view, being easily retractable and removable, and consistency with other optics such as those for night vision. Details of operational parameters will be mapped out and the efficacy of the units to perform battlefield functions will be assessed, in collaboration with Army PM/POCs as assigned.

PHASE III DUAL USE COMMERCIALIZATION: Civilian/commercial applications will ensue. Such an information delivery system is useful, particularly with regard to large scale manufacturing operations in factories where operators are on the move. A top official at Boeing Aircraft Co has articulated a well-established example to us. Scheduling steps on their "big board" are followed though by in-plant moving personnel who need to visualize the state of development of components as these are assembled into an aircraft entity being formed. Numerous other scenarios are evident. There is a very large market for head-mounted display communication system such as the one described above.

REFERENCES: Integrated Helmet Assembly Subsystem (IHAS) description under Land Warrior web pages: http://www.sbccom.army.mil/programs/lw and TRADOC publications under the TRADOC web page: http://www-tradoc.army.mil.

KEY WORDS: The key words are in categories as follows: a) TRADOC's Future Operational Capabilities (FOC), Army 2010, Land Warrior Program, soldier systems, dismounted warrior; b) Situation awareness, owning both the day and the night, information dominance, web-centric sensor and communication nets; c) Microdisplays, Helmet Mounted Displays (HMD), electroluminescence; liquid crystals, spatial light modulators, gray scales, digital versus analogue displays; d) Symbology; secure communication; command control centers on the move, communication with higher echelons by the Land Warrior.

ARMY00-T005 TITLE: Novel, Low-Cost Processing Of Functionally Gradient Ceramic-Matrix, Metal-Matrix Composite Materials

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop a processing operation, or a sequence of processing operations, to produce a low cost, functionally gradient ceramic-matrix and metal-matrix composite component.

DESCRIPTION: The desirable properties of ceramic-matrix composites (CMCs) for many applications are mitigated by their high costs and difficulty to produce as defect free structural components. The production of CMCs as liners and coatings has been demonstrated, but suffers problems with bonding to metallic substrates and assembly without damage to the liner. Continuous filament, metal-matrix composites (MMCs) have been produced by a number of techniques in complicated, near-net-shape forms. Though these have significantly improved stiffness and strength over the base metals, they are still not suitable for high wear, high temperature or chemical resistance applications that would call for a CMC. Combining the two materials into a functionally gradient system that would place the CMC in regions of high temperature, wear and/or corrosion while supported by a MMC for structural integrity, light weight and lower cost would produce a new material system with much greater commercial possibilities. This should be accomplished by combining processing techniques that are either mutually compatible or complementary in nature, but have been proven feasible on an industrial scale. In addition, engineering design issues associated with the material system and component should be investigated to determine potential problems caused by the combination of properties and to optimize performance. A typical materials system of interest would be SiC reinforced aluminum alloy tube, coupled with a SiC reinforced SiC tube liner as a potential lightweight gun tube.

PHASE I: A process sequence consisting of: 1) braiding/weaving of a tubular SiC fibre preform; 2) chemical vapour infiltration with SiC from the inside of the tube to form a fully dense inner liner; 3) vacuum assisted, pressure infiltration casting of a structural aluminum alloy from the outside to form a near-fully dense outer shell with no trapped porosity. The size of the tube shall be at a minimum of 20mm inner diameter and a maximum of 155mm inner diameter, with a minimum acceptable wall thickness of 7mm. The minimum acceptable tube length will be 70mm and the maximum included pore size in the part will be 150mm.

PHASE II: At least four test articles of specification described above will be produced. One test article will be burst-tested to failure. The results will be compared to an article of identical dimensions made from a D6AC tool steel tempered to Rc57. The second test article shall be subjected to an ASTM standard hot-gas erosion test. The results will be compared to the performance of a 4340 steel, tempered to and Rc50 and hard-chrome plated to a thickness of 300mm. The third sample will be subjected to thermal shock cycling (350oC to -15 oC in 1.5 sec) to failure (max 103 cycles). The fourth sample shall be held in reserve. A cost analysis shall be performed to estimate the cost of production of 155mm gun tubes. As part of the estimate, the reduction of weight of the gun tube should be estimated and the impact of this reduced weight on the cost of transporting the gun system should be estimated. Finally, the expected life of the gun tube should be estimated from the test data generated above.

POTENTIAL COMMERCIAL MARKET: Defense: Functionally gradient armour materials; light weight, high performance gun tubes for medium and large bore applications; high performance bearing races. Commercial: High temperature, corrosion and erosion resistant parts for the chemical industry such as pipes, valve bodies, heat transfer tubes and etc.

ARMY00-T006 TITLE: Individual Protection Against Nerve Agents

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To covalently attach enzymes that degrade nerve agents and pesticides to surfaces and skin.

DESCRIPTION: The toxicity of organophosphorus nerve agents results from their penetration through the epidermis and their entry into the general circulation, from which they can reach the nervous system. To deal with this problem, protective clothing has been developed in numerous forms. The potential utility of enzymes and biocatalysis in the detoxification of contaminated surfaces is widely accepted.1,2 Naturally occurring organophosphorus hydrolases are being incorporated into external protection systems to hydrolyze chemical agents. An alternative to incorporating the nerve agent-degrading enzymes into protective clothing would be to directly attach the enzymes to the surface of the warfighter's skin.

Methods of coupling enzymes to the skin, the entry point into the body, are the key obstacles in developing this technology. The enzymes need be coupled to the skin or other materials through covalent bonds that are resistant to washing with detergent. The enzyme must be coupled to surfaces (skin or otherwise) with chemistry or a linker that does not adversely impair the activity of the nerve agent-degrading enzyme.

PHASE I: Develop a covalent linking system and the necessary chemistry for attaching to the skin enzymes that degrade nerve agents. Show that the nerve agent-degrading enzyme is active in vitro after the linker has been attached and show that the linking chemistry does not denature the enzyme. If it is active, then attach the nerve agent-degrading enzyme to cornified layers of discarded human skin and show that the enzyme is still active against nerve agents.

PHASE II: Optimize the conditions for attachment and simplify the system for delivering the enzyme with its linker and the coupling enzyme by spraying or painting. Test animals (nude mice or rats) for protection by applying the new enzyme system and exposing them to nerve agent.

PHASE III DUAL-USE COMMERCIALIZATION: Phase III includes further identification and development of conditions for utilization of the protective enzyme systems. The catalytic activity and substrate selectivity of enzymes make them interesting catalysts for a broad variety of industrial and commercial processes. The similarity of chemical agents to commercially important organophosphorus products means that the techniques developed in this topic are directly applicable to industry. This technology would provide protection to persons exposed to pesticides in industry or to the public exposed to pesticides (golfers, etc.).

REFERENCES:

1. Longwell, P. (Chairman) National Research Council Commission on Engineering and Technical Systems. 1993. Alternative technologies for the destruction of chemical agents and munitions. 2101 Constitutions Ave., Washington, DC.

2. (a) Chen, T.-c., Rastagoi, V.K., DeFrank, J.J., and Sawaris, G.P. "G-type Nerve Agent Decontamination by Alteromonas prolidase", Annals of the New York Academy of Sciences, 864, 253-258,1998. (b) K.E. LeJeune, J.R. Wild, and A.J. Russell, "Nerve Agents degraded by Enzymatic Foams", Nature, 395, 27-28, 1998; (c) K.E. LeJeune and A.J. Russell, "Biocatalytic Nerve Agent Detoxification in Fire Fighting Foams" Biotechnology and Bioengineering, 62, 659-665, 1999.

KEY WORDS: chemical warfare agents, nerve agents, enzyme, decontamination, protection

ARMY00-T007 TITLE: Biomimetic Information Technology Systems (BITS)

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Biomedical, Electronics, Battlespace

OBJECTIVE: The creation of Biomimetic image information technology systems that can acquire optical images of the surrounding environment, process the information, and distribute the proper control responses throughout a tunable-signature material system.

DESCRIPTION: Intelligent information technology systems offer exciting new possibilities for conducting covert reconnaissance and surveillance activities and for a variety of specialized combat operations with an emphasis towards active camouflage control. Intelligent information technology systems typically consist of a dynamic network of agents interconnected via spatial and communications links that operate in uncertain and dynamically changing environments using decentralized or distributed inputs that may change over time. The agents may be sensors, information sources, or automated systems such as robots, software, and computing modules. The objective of the BITS development is an advanced system that is able to sense, analyze, learn, and provide information technology to an active camouflage system that allows it to adapt to the surrounding signatures in order to remain undetected by threat sensors in a changing or hostile environment. Examples of biological systems that exhibit this capability include chameleons and flat fish.

To accomplish this goal, BITS seeks to benefit from the direct manipulation of a process of biological origin or from engineered exploitation that derives a product mimicking a naturally occurring system. Biological systems have exquisite and highly integrated sensing capabilities that allow rapid and selective recognition and signal processing that can detect and classify targets, or the background signatures prevalent in cluttered environments. Information technology-based learning systems that are designed using biological principles offer the possibility of a new class of sensitive and rapid-response sensors.

Rapidly emerging advances in this area of scientific endeavor show substantial promise to affect a number of Army applications. The BITS must be capable of gathering relevant, available information about their environment, analyzing its significance in terms of assigned missions/functions, and defining the most appropriate course of action consistent with biomimetic decision logic. These objectives require the integration of significant scientific and technological advances in many diverse fields: physics, biology, cognitive and neural sciences, control theory and mechanisms, and systems engineering. Critical areas of research include the design and representation of hierarchical perception of targeted biological systems (chameleons or flat fish), advanced models for learning and adaptation, development of effective frameworks for representing and reasoning with uncertainty, and new computational paradigms for countering surveillance by human centered systems. The numerous potential military applications of intelligent systems include unmanned vehicles (air and ground), smart weapons, real-time C2 systems for future battlefields, and CB defense systems.

PHASE I: Develop an overall system design for optical sensors and neuromorphic processing algorithms for creating a chameleon-like system capable of masking a signature based on a 360-degree azimuth, 180-degree elevation threat viewpoints. The system should be able to sense the spectral and pattern characteristics of the environment it is located within and create a masking signature that effectively eliminates detection from any threat observation angle. The system should also outline how this processed sensor information would be spatially distributed to a cellular-array, materials system with signature shifting properties

PHASE II: Develop and fabricate an actual microsensing system complete with biomimetic image processing and feedback control. Neuromorphic processing similar to a chameleon must be demonstrated in a variety of natural environments and urban terrains. Conduct testing of the ability to sense, processes, and adapt to patterns based upon the actual environmental stimuli and the current state-of-the-art spectral signature material system capabilities. Conduct testing to prove feasibility in both simulation and realistic environments over extended operating conditions.

PHASE III DUAL USE COMMERCIALIZATION: This system would have wide utility in domestic security and law enforcement applications in the camouflage of automated surveillance equipment surfaces for perimeter security. Long-term surveillance systems and observation posts operated by the border patrol and other high-security areas could be provided with sensor and signature-control materials to adjust the camouflage much like that of a chameleon. This type of camouflage control system could provide continuous adjustment to compensate for daily and seasonal variations in signature to provide the user with situational and operational awareness without compromising the sensors' location. Additional applications include an urban beautification project for large-scale active murals, neuromorphic feedback control for active noise cancellation systems, and smart windows control systems for the minimizing the energy budget of large facilities.

REFERENCES:

1. DoD: Strategic Research Objectives: http://www.sarda.army.mil/sard-zt/ASTMP98/vol_i/sec5/sec5b8.htm, Joint Vision 2010, pp 12 and 20; CAC&FLW Pam 525-05; Engineer Vision paragraph 3-2b(3)(a). TRADOC Pam 525-200-3; TRADOC Pam 525-5; TRADOC Pam 525-75; paragraphs 3-3g and 4-5g; TRADOC Pam 525-200-2; TRADOC Black Book No.4; CAC&FLW Pam 525-05.

2. V.S. Ramachanran, C.W. Tyler, R.L. Gregory, D. Rodgers-Ramachandran, S. Duensing, C. Pillsbury, C. Ramachandran, "Rapid adaptive camouflage in tropical flounders", Nature, Vol. 379, pp. 815-818, 1996.

KEYWORDS: Biomimetic, Information Technology, Camouflage, Sensor, Signature, Adaptive, Chameleon, Surveillance

ARMY00-T008 TITLE: Coping Mechanism Assessment

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: To identify, test, and recommend technologies for developing the coping behaviors that enable individuals to deal with and avoid derailment by the difficulties encountered in completing long-term work obligations.

DESCRIPTION: Today's military is facing high rates of attrition by new soldiers who have volunteered to serve for a contracted period of time (e.g., four years). For the military, attrition creates the problems arising from non-programmed personnel turbulence. For the soldier, attrition means not meeting a work obligation that he or she agreed to and set out to achieve. There are varying reasons for attrition from the military. These reasons vary from fully involuntary (e.g., death or physical injury preventing job performance) to fully voluntary (e.g., desertion). However, most reasons fall somewhere between these extremes: academic failure, family hardship, adaptation to military life, prohibited activities (e.g., drug use), etc. Especially for those reasons with voluntary components, the reasons are also more (e.g., physical standards) or less (e.g., skill acquisition, accommodation to new social rules) unique to the military. Regardless, most new soldiers actually complete the length of their first term of service. In a number of areas, researchers and practitioners have sought to identify and promote development of the behaviors, strategies, or mechanisms which individuals successfully engage to cope with--solve, manage, or otherwise live through--the task, social, and emotional difficulties they encounter in completing work or other life pursuits. The methods for describing or otherwise measuring the coping behaviors for particular situations are open to question (e.g., Dewe, Cox, & Ferguson, 1993; O'Driscoll & Cooper, 1996). Regardless, social learning theory and its extension to self-regulation (Bandura, 1997; Wood & Bandura, 1989) are generally compatible with the hypothesized processes for goal achievement. Warehime's (1980) approach for conflict management training covered cognitive, emotional, and behavioral (actions) ways of responding to and handling conflict situations. Results for adults (Brandtstaedter & Renner, 1990) suggest that over time, responses to crises and critical life transitions may shift from an assimilative mode to an accommodative mode. The coping behaviors of specific groups have also been studied. With respect to military service members, Clemson (1996) investigated the coping skills of new recruits over the period of training for entry into service (boot camp). Relevant here is the finding (Simutis, Ward, Harman, Farr, & Kern, 1988) that soldiers eligible for, voluntarily undertaking, and successfully completing a remedial education program in basic academic skills were more likely to complete their initial terms of service than were eligible soldiers who elected not to participate. Further investigation of coping behaviors seems to have promise for the military and other organizations when focused on preventing new members from dropping out and on aiding them to complete the work obligations which they agreed to undertake.

PHASE I: In this phase, the research will focus on the reasons that new service members attrit or leave before completing the full length of their first obligation. These reasons will be examined to set forth the situational stresses and problems associated with the attrition decision. Consideration will be given to the generality of the problems across organizations and to their contribution to the rates of first-term attrition from military service. These problems will also be assessed against the literature to identify the types of coping skills, strategies or behaviors likely effective in solving, managing, or accommodating to the problems and, thereby, promoting completion of the first obligation. The literature assessment will take into account the procedures which organizations could use to train, develop, or otherwise support engagement in the coping behaviors. Based on this review, recommendations will be made of the framework of coping behaviors, skills, or strategies that is likely most useful for promoting service members' completion of their initial obligations. Procedures will also be proposed for measuring the behaviors, for developing the behaviors in first-term service members, and for empirically testing the effects of the behaviors on service continuation.

PHASE II: The proposals for the measurement, intervention, and empirical testing will be implemented, if practical, using military service members (preferably U.S. Army) as research participants. As part of the validation of the measure or the intervention, test results are to indicate the relationships between coping behaviors, adaptation to the stresses and problems to which the behaviors respond, and attrition or completion of the first term of service. Based on test results, recommendations will be made about further development of training or other interventions for improving coping behaviors.

PHASE III DUAL USE APPLICATIONS: Even though developed with a focus on completion of military service, technologies for the measurement and training of coping behaviors for obligation completion would benefit other organizations. Especially benefited would be organizations with work requirements that are long term, stressful, and requiring persistence despite the situational and personal difficulties arising during performance over time.

KEYWORDS: attrition, commitment, goal attainment, self-regulation, coping behaviors/skills/strategies

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